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|  | **Unit 1: Biochemistry** | | | | | | | |
| Name: | | Start: | | | 09/20/16 |  |  |  |
|  | | Unit Test 2: | | | 10/17/16 |  |  |  |
| Period: | | Teacher: Ms. Jost | | | |  |  |  |
|  | |  |  |  |  |  |  |  |
| **Biochemistry Part II** | | Submitted | Resubmit | Correct | Evidence of Learning | Page | Date | Sign-Off |
| **Objective 3:** Explain the double-stranded, complementary nature of DNA as related to its function in the cell. | |  |  |  | **Catalyst: Nucleotide** | 2 |  |  |
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|  |  |  | **HW: Exploring the Structure of DNA** | 5 |  |
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**Catalyst 1: Draw and label a nucleotide.**

**Catalyst 2: TBD**

**Unit 1: Biochemistry**

Start Date: 09/20/2016 Test 2 Date: 10/17/2016

**Objective 3:**Explain the double-stranded, complementary nature of DNA as related to its function in the cell.

*Essential Question:* What is the structure of DNA?

*Essential Question:* What is the structure of RNA?

*Essential Question:* How is DNA replicated?

*“I Can” Statements:*

* Identify the double-helix structure of DNA, with sides composed of alternating phosphate-sugar groups and “rungs” composed of complementary nitrogenous base pairs joined by weak hydrogen bonds
* Match DNA base-pair nucleotides (A-T, G-C) appropriately
* Develop a cause-and-effect model relating the structure of DNA to the functions of replication, transcription, and translation (protein synthesis)
* Compare/contrast DNA and RNA
* Identify the role of DNA replication in the cell cycle (allows daughter cells to have an exact copy of parental DNA)
* Explain that the sequence of nucleotides in DNA can code for proteins, but also encodes tRNA and rRNA and some stretches of DNA that appear to have no function.

**Objective 4:** Explain how DNA and RNA code for proteins and determine traits.

*Essential Question:* What are the roles of mRNA, tRNA, and rRNA in the protein synthesis process?

*“I Can” Statements:*

* Interpret a codon chart to predict the amino acids coded for by a nucleotide sequence.
* Identify the roles of the three types of RNA (tRNA, mRNA, rRNA)
* Explain the connection between nucleotide sequence and the resulting protein (Central Dogma: DNA 🡪 mRNA 🡪 protein)
* Explain the process of protein synthesis
  + Transcription that produces an RNA copy of DNA, which is further modified into the three types of RNA
  + mRNA traveling to the ribosome (rRNA)
  + Translation – tRNA supplies appropriate amino acids
  + Amino acids are linked by peptide bonds to form polypeptides. Polypeptide chains from protein molecules. Proteins can be structural (forming a part of the cell materials) or functional (hormones, enzymes, or chemical involved in cell chemistry).
* Explain how an amino acid sequence forms a protein that leads to a particular function and phenotype (trait) in an organism.
* Explain how cells can responds to their environments by producing different types and amounts of proteins by changing the expression of genes.

**Objective 5:** Explain how mutations in DNA that result from interactions with the environment (i.e. radiation and chemicals) or new combinations in existing genes lead to changes in function and phenotype.

*Essential Question:* What happens when mutations occur in DNA?

*“I Can” Statements:*

* Model how changes in nucleotide sequence (mutations) can alter the resulting protein
* Infer the advantages (injury repair) an disadvantages (cancer) of the overproduction, under production, or production of proteins at incorrect times
* Develop a cause-and-effect model in order to describe how mutations occur: changing amino acid sequence, protein function, phenotype
* Explain that changes in the DNA sequence (mutations) can be deletions, additions, or substitutions
* Explain that only mutations in the sex cells (egg and sperm) or in the gamete produces from the primary sex cells can result in heritable changes in genotype and phenotype

Biology I Honors Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Activity: Building DNA Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Directions:** Using the packet of nucleotides, you and your teammates must solve the puzzle of the structure of DNA. Using your understanding of the structure of nucleotides and how to make a polymer, fit the pieces together to make your very own polymer of DNA!

Once your group has successfully assembled a molecule of DNA, answer the following analysis questions:

**1. What two molecules make up the outside, or backbone of your DNA molecule?**

**2. How did you know how to fit the middle pieces together?**

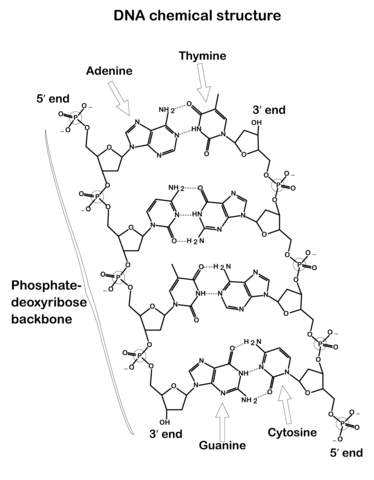
**3. Which way did you have to turn the nucleotides to get them to fit together?**

**4. What do you notice about the direction each side of the molecule is facing?**

**5. Draw your DNA molecule in the space below and label the different components:**

**Homework: Exploring the Structure of DNA**

Deoxyribonucleic acid, or DNA, is the molecule found in all cells that provides the blueprint for life. Made up of a universal code of alternating nitrogen bases (Adenine, Cytosine, Thymine and Guanine) DNA contains all an organism’s genetic instruction. Formed by millions of nucleotides, spiraling in a double-helix, the remarkable structure of DNA is crucial for its function.



1. What do the letters DNA stand for? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. What type of biomolecule is DNA?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3..  DNA is a polymer, which means that is made up of many repeating single units (monomers).  What are

the monomers  called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. What elements appear in a molecule of DNA?

5.  The “backbone” of the DNA molecule is made up of two components, what are these?

a. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6.  There are four different variations of these monomers (four different bases), what are the names of  those bases?

a. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. These bases are of two different types of molecules: purines and pyrimides.

Purines have  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ring(s) in their structure, and pyrimidines have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ring(s) in their structure.

8.  The two bases that are purines are: a. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9.  The two bases that are pyrimidines are: a. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. Which two bases pair together to complement each other? ( Hint: There are four bases but they each only match with one other base)

11. In the image, circle the difference in chemical formula between the Thymine and the Cytosine, and the difference between the Adenine and the Guanine.

12. Color the picture of the DNA molecule to show the pairing pattern of the nitrogen bases.

Biology I (Honors)

Objective 3 Notes: Structure of DNA

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_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Biology I Honors Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Foldable: DNA & RNA Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Objective 3:** Explain the double-stranded, complementary nature of DNA as related to its function in the cell.

Materials needed:

-colored sheet of paper from Ms. J

-scissors

-glue

1. Fold the colored sheet of paper in half like a hotdog.
2. You need to create 3 flaps. This can be done by making 2 cuts.
3. Label the flaps like the diagram below. (Dotted lines represent where cuts should be made.)
4. Under the DNA flap, write 4 points that are specific to DNA.
5. Under the RNA flap, write 4 points that are specific to RNA.
6. Under the similarity flap, write 3 similarities between the 2 nucleic acids.
7. Glue the foldable over the picture below.

DNA

Similarities

RNA

Biology I Honors Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Venn Diagram: DNA & RNA Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Objective 3:** Explain the double-stranded, complementary nature of DNA as related to its function in the cell.

**Complete the Venn diagram below using the following words or phrases:**

* A kind of nucleic acid
* Adenine (A)
* Makes up chromosomes
* Composed of nucleotides
* Contains sugars
* Contains nitrogenous bases
* Cytosine (C)
* Deoxyribose sugar
* Double stranded
* Guanine (G)
* Inherited genetic information
* Phosphate groups
* Produced by transcription
* Remains in the nucleus
* Ribose sugar
* Ribosomes are made of this
* Single stranded
* Template for replication
* Template for transcription
* Thymine (T)
* Travels between nucleus and cytoplasm
* Uracil (U)

**DNA RNA**

Biology (Honors) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lab: DNA & RNA Cut-out Lab Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Introduction:**

Deoxyribonucleic acid (DNA) is a complex molecule found in all living organisms. It is the chemical of which genes are composed. An understanding of the organization of this molecule has answered many questions. Scientists now know how chromosomes can duplicate during cell division and transfer their genetic information to new chromosomes. Scientists also understand how chromosomes in the cell nucleus can direct the formation of specific proteins outside the nucleus.

In this investigation, you will:

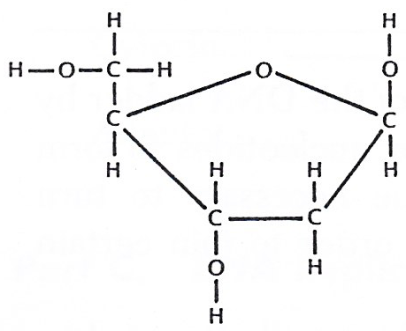
1. learn the names of the molecules that make up DNA
2. use models to construct a molecule of DNA and show how it replicates
3. learn the names of the molecules that make up RNA

**Materials:**

* Scissors
* Model parts (save all of these!)

**Procedure:**

**Part A: Structure of DNA Nucleotides**

Two important molecules which make up DNA are deoxyribose and phosphoric acid. Their models and structural formulas are shown here.

















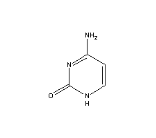
Deoxyribose Phosphoric acid

In addition, there are four different molecules called bases. Their structural formulas and models are shown here and in your textbook.





***Adenine*** ***Thymine***







***Guanine Cytosine***

* 1. What elements are present in:
     1. Deoxyribose: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     2. Phosphoric acid: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     3. Guanine: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     4. Adenine: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  2. A molecule of deoxyribose joins with phosphoric acid and any one of the four bases to form a chemical compound called a *nucleotide*. One of the four nucleotides is shown here as a model. This happens to be a thymine nucleotide because of the thymine base attached to the deoxyribose.  
     1. List the *other* three types of nucleotides:
        1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
        2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
        3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part B: Structure of a DNA molecule:**

A DNA molecule is “ladderlike” in shape. Deoxyribose and phosphoric acid molecules join to form the side or uprights of the ladder. Base molecules join together to form the rungs of the ladder.

* 1. *Cut out the nucleotide models. Cut along solid lines only.*
  2. *Fit four nucleotides together in puzzle-like fashion to form a row in the following sequence:* Cytosine, Thymine, Guanine, Adenine. *This will represent the left half of the ladder molecule.*
  3. What are the two molecules that make up the upright (side) portion of DNA?
     + 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  4. What are the four bases that make up the rungs (middle) portion of DNA?
     + 1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  5. Adenine always bonds with \_\_\_\_\_\_\_\_\_\_\_\_ while Guanine always bonds with \_\_\_\_\_\_\_\_\_\_\_\_.
  6. The following are the bases on the left side of a DNA molecule. List the bases that would make up the right side of the DNA molecule:
     + 1. Thymine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       2. Adenine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       3. Guanine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       4. Guanine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       5. Cytosine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       6. Thymine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       7. Cytosine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       8. Adenine - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  7. *Complete the right side of the DNA ladder by matching the bases of other nucleotides to form complete rungs. You may work with the person sitting at your desk to do this. It may be necessary to turn molecules upside down in order to join certain base combinations.* Note: *the ends of each base will allow only a specifically shaped matching new base to fit exactly.*
  8. Your completed model should look like a ladder with matched bases as the rungs. Besides being shaped like a ladder, a DNA molecule is twisted. It looks like a spiral staircase. However, your paper model cannot show this.
  9. What is the twisted shape of a DNA molecule called: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Part C: DNA Replication**

A chromosome contains DNA. Your DNA model represents only a short length of the DNA portion of a chromosome. An entire chromosome has thousands of rungs rather than only four. Although your model is only a small part of a chromosome, its replication is the same as that of an entire chromosome during mitosis and meiosis.

* 1. *Open your DNA model along the point of attachment between base pairs (rungs) and separate the two ladder halves. (A chromosome untwists and unzips in a similar way prior to replication).*
  2. *Using the left half of your model as a pattern, add new nucleotides to form a new right side. You may work with the people at the desk next to yours to accomplish this.*
  3. *Build a second DNA model by adding new nucleotides to the right half of the original model.*
  4. Do the new molecules contain the same number of rungs? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Yes or No)
  5. Is the order from top to bottom of base pairs (rungs) different or the same for each new DNA molecule? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  6. Are the new molecules exact copies of each other? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Yes or No)
  7. The specific order of bases in DNA serves as a code or language. When a chromosome replicates, the code (the order in which the bases occur) is carried over to the new chromosome.
  8. Do both strands of DNA run in the same direction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Yes or No). Explain why or why not: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part D: RNA Structure**

Besides ensuring the exact replication of chromosomes, the sequence, or order, and pairings of bases are a genetic code of the instructions for the entire cell. How does a cell “read” and “translate” the chemical message coded in its DNA in the form of specific base sequences? Part of the answer lies with a second molecule in the nucleus of cells called ribonucleic acid (RNA).

RNA is similar to DNA in that its molecules also form nucleotides. However, deoxyribose and thymine are not found in RNA. Two other molecules, ribose and uracil, are present. Ribose replaces deoxyribose, and uracil replaces thymine. Looking at their structural formulas and models, you will see certain similarities between the molecules that they replace.

**H**

**2**

**C**

**CH**

**HC**

**CH**

**C**

**H**

**HO**

**HO**

**O**

**H**

**O**

**H**

**O**

* 1. Determine the molecular formula for:
     + 1. Ribose C\_\_\_H\_\_\_O\_\_\_

## Ribose

* + - 1. Deoxyribose C\_\_\_H\_\_\_O\_\_\_

**H**

**2**

**C**

**CH**

**HC**

**CH**

**CH**

**2**

**HO**

**HO**

**OH**

**O**



# Deoxyribose Uracil

* 1. How do these two compounds differ? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. Examine the shape of the uracil model. With what base can it match to form a complete rung?

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Part E: RNA Transcription**

* 1. *Cut out the RNA nucleotides. Cut along the solid lines only.*
  2. *Open (“unzip”) one of the DNA chromosomes along the base pair points of attachment and separate the two halves.*
  3. *Using the right side of your DNA model as a pattern, match RNA nucleotides with the proper nucleotides of the DNA half.*
  4. Is the sequence or order of the bases in RNA different from the unused left side of the original DNA molecule? (Do not consider uracil replacing thymine as a change in sequence). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  5. Do the RNA half-rung bases pair exactly as they would if this were DNA replication? \_\_\_\_\_\_
  6. *Remove the RNA nucleotide series from the DNA pattern.*
  7. *Close the DNA molecule back up with its original left side. (DNA molecules “unzip” temporarily during RNA production.)*
  8. RNA is a single-stranded molecule. Thus, the series of RNA nucleotides formed from DNA represents an RNA molecule. After its formation, this RNA leaves the nucleus of the cell and goes to the ribosomes. It carries the DNA message of base sequences in the exact same order. This step of the entire process is, therefore, called transcription.
  9. Explain how specific pairing of adenine with only uracil and of cytosine with only guanine helps ensure transcription of the code from DNA to RNA. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Analysis**

1. Complete the table below by placing X’s in the boxes to indicate to which molecule each characteristic applies.

|  |  |  |
| --- | --- | --- |
|  | **DNA** | **RNA** |
| Ribose present |  |  |
| Deoxyribose present |  |  |
| Phosphoric acid present |  |  |
| Adenine present |  |  |
| Thymine present |  |  |
| Uracil present |  |  |
| Guanine present |  |  |
| Cytosine present |  |  |
| Double stranded |  |  |
| Single stranded |  |  |
| Remains in nucleus |  |  |
| Moves out of nucleus |  |  |

1. Explain how RNA is involved in the passing of the DNA code to the rest of the cell.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



Biology (Honors) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lab: Edible DNA Period: \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**Objective 3:** Explain the double-stranded, complementary nature of DNA as related to its function in the cell.

**Introduction:**

DNA provides the instructions for building and operating all living things. The DNA instructions are divided into segments called genes. Each gene provides the information for making a protein, which carries out a specific function in the cell.

A molecule of DNA (Deoxyribonucleic Acid) is composed of two backbones and four types of chemical bases. The backbone is formed by a chain of alternating phosphates and sugars. Each sugar molecule in the backbone provides an attachment site for one of the chemical bases. The four types of chemical bases are: adenine, thymine, cytosine and guanine. They usually are represented by their first letters: A, T, C and G. The bases form pairs in a very specific way: A always pairs with T, and C always pairs with G. A pair of bases is connected by hydrogen bonds. Each base in the pair is also connected to a sugar compound in the DNA backbone.

A DNA molecule is often compared to a ladder, with the two backbones forming the sides of the ladder and the base pairs forming the steps, or rungs. However, instead of a straight ladder, DNA looks like a twisted ladder, known as a double helix (“double” for the two backbones). The DNA sequence is the consecutive order of bases on one side, or strand, of the twisted ladder. The other strand has a complementary sequence determined by the base pairing rules.

The specific matching of the base pairs, A with T and C with G, provides a way for exact copies of DNA to be made. This process is called DNA replication. In DNA replication, the double helix ladder is untwisted and the two strands are separated by breaking the hydrogen bonds between the base pairs. Next, two new strands are made by reading each side of the DNA ladder, one step (base) at a time. At each step, the matching base fills in (with its associated sugar and phosphate) to complete the rung and lengthen the new DNA strand. When the process is complete, there are two identical DNA double helices, each containing one original and one new strand.

DNA replication is an important part of the cell division process. Before a cell divides, it first duplicates its DNA so that the new cell will have the same genetic information. The specific base pair matching during replication ensures that exact DNA copies are made.

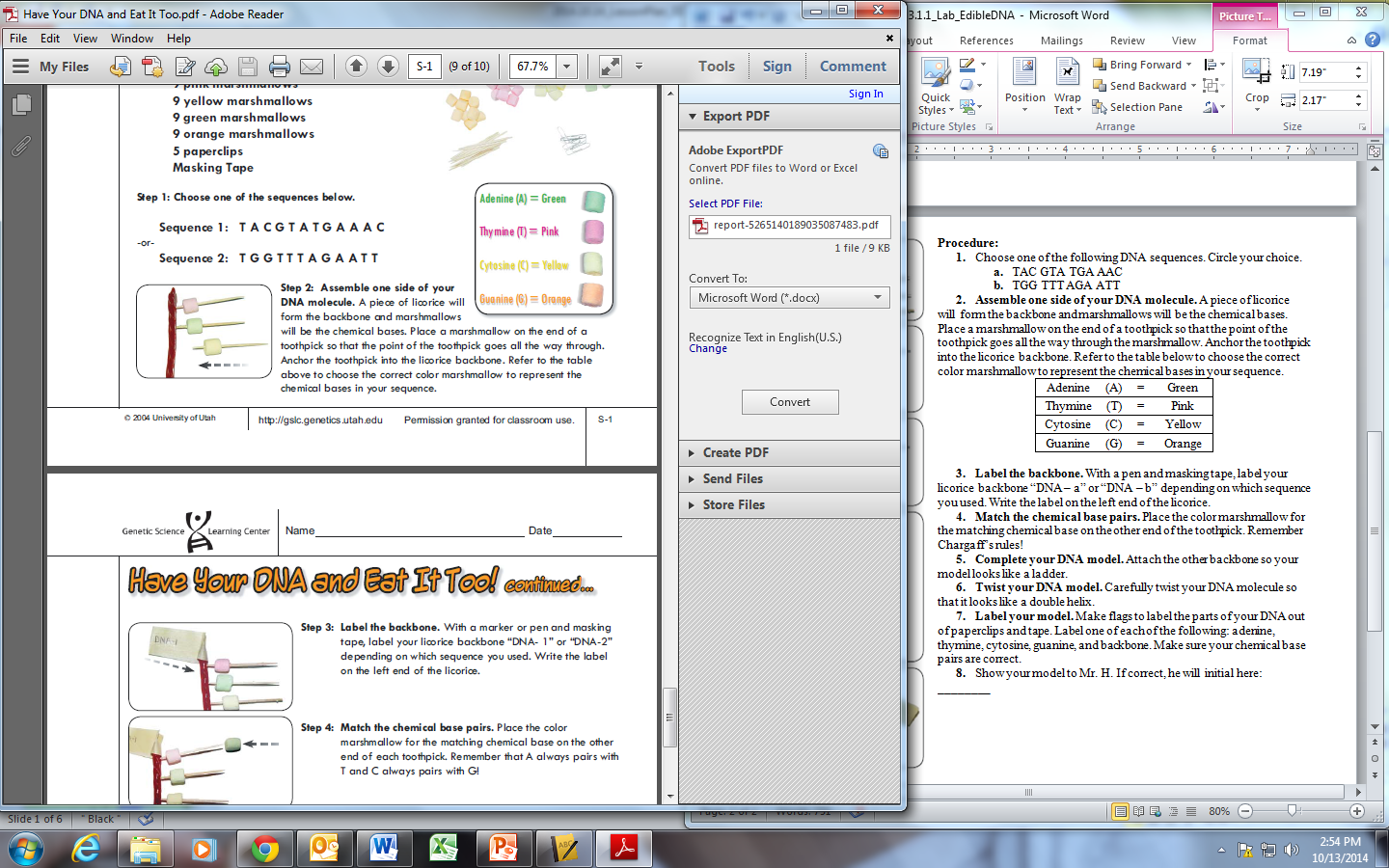
**Task:**

Your task is to use the following materials and procedure to construct an edible model of DA. When you are finished, used toothpicks and tape to label one of each of the chemical bases.

**Materials:**

* Licorice
* Toothpicks
* Pink marshmallows
* Yellow marshmallows
* Green marshmallows
* Orange marshmallows
* Paperclips
* Masking tape
* Scissors

**Procedure: Building a DNA Molecule**

1. Choose one of the following DNA sequences. Circle your choice.
   1. TAC GTA TGA AAC
   2. TGG TTT AGA ATT
2. **Assemble one side of your DNA molecule.** A piece of licorice will form the backbone and marshmallows will be the chemical bases. Place a marshmallow on the end of a toothpick so that the point of the toothpick goes all the way through the marshmallow. Anchor the toothpick into the licorice backbone. Refer to the table below to choose the correct color marshmallow to represent the chemical bases in your sequence.

|  |  |  |  |
| --- | --- | --- | --- |
| Adenine | (A) | = | Green |
| Thymine | (T) | = | Pink |
| Cytosine | (C) | = | Yellow |
| Guanine | (G) | = | Orange |

1. **Label the backbone.** With a pen and masking tape, label your licorice backbone “DNA – a” or “DNA – b” depending on which sequence you used. Write the label on the left end of the licorice.



1. **Match the chemical base pairs.** Place the color marshmallow for the matching chemical base on the other end of the toothpick. Remember Chargaff’s rules!



1. **Complete your DNA model.** Attach the other backbone so your model looks like a ladder.



1. **Twist your DNA model.** Carefully twist your DNA molecule so that it looks like a double helix.



1. **Label your model.** Make flags to label the parts of your DNA out of paperclips and tape. Label one of each of the following: adenine, thymine, cytosine, guanine, and backbone. Make sure your chemical base pairs are correct.
2. Show your model to Ms. J. If correct, she will initial here: \_\_\_\_\_\_\_\_

**Procedure: Demonstrating Replication**

1. **Topoisomerase:** Unwind your DNA molecule and lay it flat on the table.
2. **Helicase:** Use scissors to open your DNA molecule along the point of attachment between the base pairs (i.e., cut through the middle of the toothpicks). Separate the two halves of your DNA molecule.
3. **DNA Polymerase:** Using the left half of your model as a pattern, add new nucleotides to form a new right side. Build a second DNA model by adding new nucleotides to the right half of the original model. Remember Chargaff’s rules!
4. Do the new molecules contain the same number of rungs as the original DNA strand? \_\_\_\_\_\_\_\_\_\_\_\_
5. Is the order from top to bottom of base pairs (rungs) different or the same for each new DNA molecule? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Are the new molecules exact copies of each other? \_\_\_\_\_\_\_\_\_\_\_\_\_
7. The specific order of bases in DNA serves as a code or language. When a chromosome replicates, the code (the order in which the bases occur) is carried over to the new chromosome.
8. Do both strands of DNA run in the same direction? \_\_\_\_\_\_\_\_\_\_\_\_\_ Explain why or why not: \_\_\_\_\_\_  
   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Analysis Questions:**

1. Explain the double-stranded, complementary nature of DNA.

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1. Explain how the specific pairing of adenine with only thymine and guanine with only cytosine helps preserve the integrity of the DNA molecule.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. Explain how RNA is involved in the passing of the DNA code to the rest of the cell.

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**HW: History of the Structure of DNA**

**Watson and Crick describe structure of DNA --1953**

In the late nineteenth century, a German biochemist found the nucleic acids, long-chain polymers of nucleotides, were made up of sugar, phosphoric acid, and several nitrogen-containing bases. Later it was found that the sugar in nucleic acid can be ribose or deoxyribose, giving two forms: RNA and DNA. In 1943, American Oswald Avery proved that DNA carries genetic information. He even suggested DNA might actually *be* the gene. Most people at the time thought the gene would be protein, not nucleic acid, but by the late 1940s, DNA was largely accepted as the genetic molecule. Scientists still needed to figure out this molecule's structure to be sure, and to understand how it worked.

In 1948, Linus Pauling discovered that many proteins take the shape of an alpha helix, spiraled like a spring coil. In 1950, biochemist Erwin Chargaff found that the arrangement of nitrogen bases in DNA varied widely, but the amount of certain bases always occurred in a one-to-one ratio. These discoveries were an important foundation for the later description of DNA.

In the early 1950s, the race to discover DNA was on. At Cambridge University, graduate student [Francis Crick](http://www.pbs.org/wgbh/aso/databank/entries/bocric.html) and research fellow James Watson (b. 1928) had become interested, impressed especially by Pauling's work. Meanwhile at King's College in London, Maurice Wilkins (b. 1916) and [Rosalind Franklin](http://www.pbs.org/wgbh/aso/databank/entries/bofran.html) were also studying DNA. The Cambridge team's approach was to make physical models to narrow down the possibilities and eventually create an accurate picture of the molecule. The King's team took an experimental approach, looking particularly at x-ray diffraction images of DNA.

In 1951, Watson attended a lecture by Franklin on her work to date. She had found that DNA can exist in two forms, depending on the relative humidity in the surrounding air. This had helped her deduce that the phosphate part of the molecule was on the outside. Watson returned to Cambridge with a rather muddy recollection of the facts Franklin had presented, though clearly critical of her lecture style and personal appearance. Based on this information, Watson and Crick made a failed model. It caused the head of their unit to tell them to stop DNA research. But the subject just kept coming up.

Franklin, working mostly alone, found that her x-ray diffractions showed that the "wet" form of DNA (in the higher humidity) had all the characteristics of a helix. She suspected that all DNA was helical but did not want to announce this finding until she had sufficient evidence on the other form as well. Wilkins was frustrated. In January, 1953, he showed Franklin's results to Watson, apparently without her knowledge or consent. Crick later admitted, "I'm afraid we always used to adopt -- let's say, a patronizing attitude towards her."

Watson and Crick took a crucial conceptual step, suggesting the molecule was made of two chains of nucleotides, each in a helix as Franklin had found, but one going up and the other going down. Crick had just learned of Chargaff's findings about base pairs in the summer of 1952. He added that to the model, so that matching base pairs interlocked in the middle of the double helix to keep the distance between the chains constant.

Watson and Crick showed that each strand of the DNA molecule was a template for the other. During cell division the two strands separate and on each strand a new "other half" is built, just like the one before. This way DNA can reproduce itself without changing its structure -- except for occasional errors, or mutations.

The structure so perfectly fit the experimental data that it was almost immediately accepted. DNA's discovery has been called the most important biological work of the last 100 years, and the field it opened may be the scientific frontier for the next 100. By 1962, when Watson, Crick, and Wilkins won the Nobel Prize for physiology/medicine, Franklin had died. The Nobel Prize only goes to living recipients, and can only be shared among three winners. Were she alive, would she have been included in the prize?

Citation: "Watson and Crick Describe Structure of DNA 1953." *PBS*. PBS, n.d. Web. 19 Sept. 2016.

**Response Questions:**

1. What contributions to the discovery of DNA was made by the following people:

a. Oswald Avery:

b. Linus Pauling

c. Erwin Chargaff

2. What approach to figuring out the structure of DNA did the Cambridge team take? What approach did the King’s team take?

3. Considering Rosalind Franklin’s x-ray crystallography photos as a key link in the puzzle of the structure of DNA, many argue that she was deserving of the Nobel Peace Prize, not Watson and Crick. What do you think? Justify your answer.

Biology (Honors) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lab: DNA Extraction Period \_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

**3.1.1:** Explain the double-stranded, complementary nature of DNA as related to its function in the cell.

***Background:*** The long, thick fibers of DNA store the information for the functioning of the

chemistry of life. DNA is present in every cell of plants and animals. The DNA found in

strawberry cells can be extracted using common, everyday materials. We will use an extraction

buffer containing salt, to break up protein chains that bind around the nucleic acids, and dish

soap to dissolve the lipid (fat) part of the strawberry cell wall and nuclear membrane. This

extraction buffer will help provide us access to the DNA inside the cells.

***Pre-lab question:***

1. What do you think the DNA will look like?

***Materials:***

***heavy duty ziploc bag***

1 strawberry

10 mL DNA extraction buffer (soapy, salty water)

cheesecloth

funnel

50mL vial / test tube

glass rod, inoculating loop, or popsicle stick

20 mL ethanol

***Procedure:***

1. Place one strawberry in a Ziploc bag.

2. Smash/grind up the strawberry using your fist and fingers

for 2 minutes. Careful not to break the bag!!

3. Add the provided 10mL of extraction buffer (salt and

soap solution) to the bag.

4. Kneed/mush the strawberry in the bag again for 1 minute.

5. Assemble your filtration apparatus as shown to the right.

6. Pour the strawberry slurry into the filtration apparatus and let it drip directly into your

test tube.

7. Slowly pour cold ethanol into the tube. OBSERVE ☺

8. Dip the loop or glass rod into the tube where the strawberry extract and ethanol layers

come into contact with each other. OBSERVE ☺

***Conclusions and Analysis***

1.It is important that you understand the steps in the extraction procedure and why each step

was necessary. Each step in the procedure aided in isolating the DNA from other cellular

materials. Match the procedure with its function:

***PROCEDURE FUNCTION***

A. Filter strawberry slurry through cheesecloth \_\_\_\_\_\_ To precipitate DNA from solution

B. Mush strawberry with salty/soapy solution \_\_\_\_\_\_\_ Separate components of the cell

C. Initial smashing and grinding of strawberry \_\_\_\_\_\_\_ Break open the cells

D. Addition of ethanol to filtered extract \_\_\_\_\_\_\_ Break up proteins and dissolve cell membrane

2. What did the DNA look like? Relate what you know about the chemical structure of DNA to

what you observed today.

3. Explain what happened in the final step when you added ethanol to your strawberry extract.

(Hint: DNA is soluble in water, but not in ethanol)

4. A person cannot see a single cotton thread 100 feet away, but if you wound thousands of

threads together into a rope, it would be visible much further away. Is this statement

analogous to our DNA extraction? Explain.

5. Why is it important for scientists to be able to remove DNA from an organism? List two

reasons.

6. Is there DNA in your food? \_\_\_\_\_\_\_\_ How do you know?